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Teaching Point
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Hereditary nephrogenic diabetes insipidus: a major conundrum during labour and delivery

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Introduction

Hypernatremia will develop when a patient with nephrogenic diabetes insipidus cannot drink enough water to match her large obligatory urinary water loss. In preparation for monitoring labor and delivery in a woman with hereditary nephrogenic diabetes insipidus (NDI), our objective was to avoid dysnatremias and plan how to treat one should one occur. Specific concerns were raised regarding her ability to ingest and absorb enough water to match her usual urine flow rate of 10 ml/min, unreliable gastric emptying and intestinal motility, the possible need for rapid infusions of very hypotonic solutions and hyperglycemia, if large amounts of glucose-containing solutions would be infused.

Case presentation

A 26-year-old primigravida had NDI based on heterozygosity for the c.749delA aquaporin 2 (AQP2) mutation. Throughout pregnancy her 24-h urine volume was 10–15 L (creatinine excretion rate was consistent with her muscle mass); urine osmolality was ∼100 mOsm/L, sodium (Na) excretion rate was 167 mmol/day and plasma Na concentration (P_{Na}) was consistently ∼136 mmol/L.

Labour was induced at 41 weeks. In order to follow hourly fluid balance, a Foley catheter was inserted and the P_{Na} was measured q4h. Sweat loss volume could not be quantified. Labour lasted 36 h, and oxytocin was infused for the last 21 h. She received intravenous saline at the discretion of the obstetrical team, penicillin G for group B streptococcus prophylaxis and metoclopramide to prevent nausea; she did not vomit. She was able to drink water *ad lib* throughout labour and postpartum.

Laboratory data are summarized in Table 1. During the 36 h of labour, P_{Na} remained near constant; however, 12 h postpartum, her P_{Na} declined progressively to a nadir of 124 mmol/L at which time she complained of headache.

She was oriented to person and place (but not time). Neurological exam was unremarkable. The blood pressure was 130/80 mmHg, without a postural drop or tachycardia. Jugular venous pressure was 1 cm above the sternal angle. There was no peripheral oedema. Water diuresis was ongoing at 0.6 L/h.

Urgent intervention was deemed necessary in the presence of symptomatic, acute hyponatraemia to prevent further decline in her P_{Na}, particularly if gastric emptying occurred rapidly, resulting in absorption of a large amount of water, rapid decline in the arterial P_{Na} and potentially brain swelling and herniation [1].

Isotonic saline was chosen for treatment—in addition to oral water restriction for 1 h while awaiting follow-up laboratory data—since there was a large, ongoing water diuresis (0.6 L/h), and an infusion of 0.6 L of in the next hour would result in a nil water balance and a positive balance of 90 mmol of Na^+, raising P_{Na} by ∼3 mmol/L. Upon reflection, it would have been better to infuse enough hypertonic saline to raise the P_{Na} by 3 mmol/L at the outset, as this was a medical emergency and there could have been a dangerous fall in the P_{Na} if a large volume of water was released from the stomach during this period. Nevertheless, the P_{Na} rose initially by 3 mmol/L over the first 2 h and to 134 mmol/L over 10 h. She was discharged home in stable condition, with a healthy newborn that did not carry the AQP2 mutation.

Teaching points

The following issues are relevant to this woman's future pregnancies and/or to other women's in similar situations:

Table 1. Fluid balance, plasma and urinary sodium concentrations.

Period (h)	Intake (L)				Urine output (L)	Urine U_{Na} (mmol/L)	P_{Na} observed (mmol/L)	P_{Na} predicted (mmol/L)
	0.9% saline	0.45% saline	Oral water	Total				
Period 1(0–36)	4.2	1.0	16.5	22	14.9	16	134	126
Period 2 (37–59)	1.0	1.9	9.9	13	9.2	13	124	126
Period 3 (60–80)	2.3	0.7	8.9	12	10.4	13	134	134

P_{Na}, plasma sodium concentration; U_{Na}, urine plasma concentration.
The total observation period for this patient consisted of 80 h (36 in labour and 44 postpartum). These were divided into three periods: period 1 (labour, hours 1–36); period 2 (early postpartum, hours 37–59, when her P_{Na} fell); and period 3 (late postpartum, hours 60–80 when her P_{Na} rose).

(1) Water balance must be followed closely, particularly postpartum. In our patient, as P_{Na} fell in period 2, P_{Na} and urine output should have been measured more frequently. As soon as the P_{Na} fell by 3 mmol/L, the intake of water should have been curtailed and the hourly urine output should have been matched by an infusion of isotonic saline up to the volume predicted for a positive Na^+ balance to raise the P_{Na} by 4 mmol/L. The P_{Na} should be measured frequently to avoid large unwanted swings in the P_{Na}, the most dangerous being the development of acute, symptomatic hyponatraemia.

(2) There is a theoretical risk involved when relying on oral water intake during labour (or in other situations) where the blood supply to the splanchnic area may decline markedly. Labour is known to induce vasopressin secretion and this patient also received high doses of oxytocin. Vasopressin and possibly oxytocin-mediated vasoconstriction of the splanchnic circulation may slow the absorption of ingested fluids [2–5]. With marked slowing of portal venous and capillary blood flow, there may be rapid absorption of free water and haemolysis in splanchnic capillaries. Therefore, it may be advisable to stop the oral intake late in labour as delivery approaches and switch to the intravenous administration of an equal mixture of hypotonic saline and D_5W at a rate equal to the urine output.

(3) Tonicity balance should be calculated to predict a change in P_{Na}. Both a tonicity balance and electrolyte-free water balance calculations reveal how much the P_{Na} will change, but only tonicity balance can reveal the basis for this change in terms of Na^+ and water loss or gain [6,7]. P_{Na} was similar when predicted by both approaches and by direct measurement (Table 1) with one exception: the expected P_{Na} by the end of labour and delivery (period 1) was predicted to be 126 mmol/L (Figure 1), while the measured value was 134 mmol/L. We surmise that this discrepancy was due to an estimated sweat loss of 3.6 L over the 36 h of labour (i.e. 100 mL/h). Estimates of sweat loss during labour have not been reported, but sweat rates can reach 1–1.5 L/h during high-intensity exercise in the heat [8].

(4) Finally, a form of NDI occurs in all newborns lasting close to 1 month [9–13]; hence physiologic studies to determine if the child is affected are not indicated during the first month of life. The mother must know in advance that it is normal to have a large excretion of water in this period.

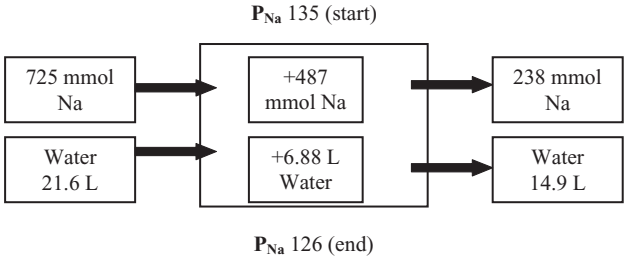

Fig. 1. Tonicity balance for period 1 (labour). Based on the input and urine output, the P_{Na} should have declined. Notwithstanding, a loss of 0.1 L/h in sweat would be needed to have a final P_{Na} that matched the measured P_{Na} at the end of this period. [1]Tonicity balance calculation: for every micromol of Na^+ gained per litre of total body water (TBW), P_{Na} will increase by 1. For every litre of water gained, P_{Na} will decrease as follows: $P_{Na} \times (1/TBW)$. TBW calculation: weight (kg) $\times$ 0.511 as reported [14]. Total body water: 93 kg $\times 0.511 = 48$ L

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Conflict of interest statement. None declared.

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